Ethnomathematics in the Classroom

An Honors Thesis (HONR 499)

by

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Abstract

Ethnomathematics is an avenue for teachers to relate mathematical knowledge with their students. By utilizing aspects of culture a teacher can help students make connections between mathematics and the world around them. Integrating different cultures, ancient, popular, and the students', provides the teacher with a base to construct and facilitate engaging mathematics lessons.

The lessons that resulted from this research are intended for current and prospective educators and aligned with intermediate and middle school mathematics standards. By providing educators with a few ideas of how to incorporate various cultures into mathematics education, teachers will in turn be encouraged to engage students in meaningful and culturally relevant mathematical instruction.

Acknowledgements

I would like to thank Dr. Elizabeth Bremigan for her support and advice throughout this process. My words cannot express the gratitude I have for her guidance with this thesis and my time at Ball State University.

I would also like to thank my parents, Larry and Shellee, for their constant motivation and encouragement. Also, special thanks to Margaret Gallina for taking a break from her first job to be my sounding board.

Mathematics is an integral part to the world today as well as how it was centuries ago. Educators have the responsibility not only to teach children the mathematics they will need to be successful in life, but to also connect the content to the students' lives in meaningful ways. Ideally, students get to the point where they make connections about math and the world around them. Ethnomathematics is "the relationship between culture and mathematics" (D'Ambrosio 2001). Ethnomathematics helps teachers create initial connections related to different aspects of various cultures represented in the classroom. There are several parts to culture including "language, codes, values, jargon, beliefs, food and dress, habits, and physical traits" (D'Ambrosio 2001). These aspects of culture can be entry points for meaningful mathematics instruction that is rooted in the students' cultures. In addition, ethnomathematics helps students see other cultures and how mathematics is integrated into that culture. By teaching with ethnomathematics in mind, teachers acknowledge and show how mathematics is important in all cultures and how culture impacts mathematics. Mathematics is not just numbers and operations, it is creativity and application, and it is in American culture through shopping, sharing, baking, clothing patterns, and solving problems in the community.

When teaching using ethnomathematics there are several ways to teach content. One way is to utilize a different culture outside of your classroom. Another is using a culture that is current, yet unfamiliar for some students. And the third is using a culture that is current and familiar to all students. Some aspects of culture that could be used include calendars, the Mayan number system, and fashion. One way to plan meaningful lessons is to use the cultures of the classroom where students explain and share information about the specific aspect of that culture. Knowing the students can help the teacher create activities that are engaging and that the students can relate to. One strategy to determining what aspect of culture to use for instruction is to ask students what is most important to their family or what part of their culture are they most proud of. Once a part of the culture of the students is identified, then the teacher can prepare a lesson based on their cultural interests. When presenting information about students' own culture, an educator can talk to the students about it. Before instruction, teachers can ask students if they are willing to share information with the class or have someone else share and they chime in. Encouraging students to ask questions about other cultures is growing ever vital in a world where people are afraid of the unknown. The purpose of ethnomathematics is to bring value and respect to other cultures, so classrooms do not simply focus on Western mathematical thinking.

Culture is vital to mathematics. It provides a context for mathematics to occur and be observed. We can look at past cultures and explain the mathematics they used in present day terms. Often mathematics was integrated throughout culture and was not a separate entity, as it is often viewed today (Ascher 1991). However, numbers and mathematics are integrated into business and finances, as well as other aspects of our modern society. The similarities across cultures, in regards to the incorporation of mathematical ideas, is one that still exists in today's society. Utilizing a variety of cultures to teach mathematical concepts exposes students to different ways of thought, which in turn encourages students to be more open-minded. Basing mathematical instruction in other cultures is related to educating students about diversity and accepting multiple methods of solving problems.

As students advance mathematically, educators can use more complex business situations, life science, or even physics to teach content. Some topics that can be taught with real-world modeling include linear functions, exponential functions, logarithmic functions, and systems of equations. In present day it is vital for educators to base lessons around contexts with which students are familiar. This type of planning and instruction is rooted in constructivism, where students construct their own knowledge based on what they already know (Santrock 2005). These contexts, depending on the students in the class, could include comparing cell phone plans, using and buying gasoline if the students are of driving age, buying food for a party depending on the number of people that will be in attendance, scaling a recipe, dividing up a canvas for a painting, determining the percentage of a newspaper that is advertisements, stories, or photos. Presenting mathematics in a context allows students to make connections and build their own knowledge of the material.

The challenge of educators is to always provide students with a relevant cultural context. Teaching with cultural differences in mind is called multiculturalism, where other cultures are recognized, valued, and used as a basis for instruction (Kauchak 2008). As with planning engaging units and projects for problem-based learning, starting with one lesson or unit is better than none at all. When tackling a new challenge, such as planning a lesson or unit in a different context, it is daunting. Teaching with a different culture as a base requires research for the teacher to be knowledgeable and respectful to the people and traditions of the culture. Due to the challenge of gathering knowledge and materials to teach mathematics in this context, it is less daunting to start with one lesson or one unit. In doing so, students will feel valued and the teacher will be using a multicultural approach to education.

Using Ancient Cultures to Teach Mathematics

There are many cultures that are mathematically intriguing but are not recognized as contributing to the formation of modern mathematics as it is taught in schools. Marcia Ascher, one of the founders and leaders in ethnomathematics research, provides a look into several smaller, more traditional cultures and how they tie into modern mathematics.

Marshall Island

One civilization Ascher writes about is the Marshall Islanders. There was no one way for the Islanders to navigate the waters between the islands, so stick charts were created for guidance and helped the sailors determine the best way, depending on the weather and currents. The Islanders used exemplars of stick charts, similar to Figure A, to help instruct the younger generation how to sail the waters and get from landmass to landmass. The stick charts were used to show the current of the water depending on whether it is moving from shallow to deep, deep to shallow, around atolls, or around an island. Sailors memorized the chart before departure and used their intuition to help them navigate the swells. The stick charts, much like the maps we use today, helped people get from one place to another, but instead of roads the Marshall Islanders traveled by water (Ascher 2002).

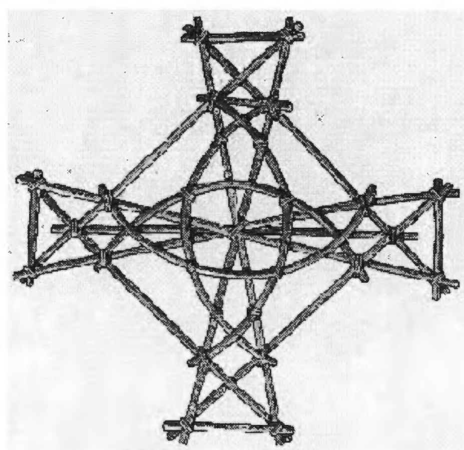

Figure A

Upon reading information regarding stick charts, I was utterly confused, perhaps because I have no experience in sailing or nautical navigation. Once I processed a bit more about stick charts, I made a connection to my knowledge about physics and how water refracts when going from one depth to another. While this connection would not fully enable me to utilize the stick charts of the Marshall Islanders, I was able to gain an understanding of how these charts were created and used. From analyzing the charts to see how mathematics was represented to being confused about how the charts were used, it was made evident that in order to make a connection to the information it must be a part of your culture or you must have background knowledge about the context.

Tamil Nadu, India

Another culture Ascher discusses in her book is that of Tamil Nadu, India. She discusses the significance of kolam in the culture. Kolam is created using rice powder to form a decorative design in front of houses in Tamil Nadu in southern India. The rice powder is used to create patterns, sometimes related to holidays or events in the family's life. Kolam designs are made using dots and lines, sometimes the dots are connected and some designs call for the lines to pass between the dots. Some kolam are made from one continuous line, and others with several lines repeated in the same pattern (Ascher 2002).

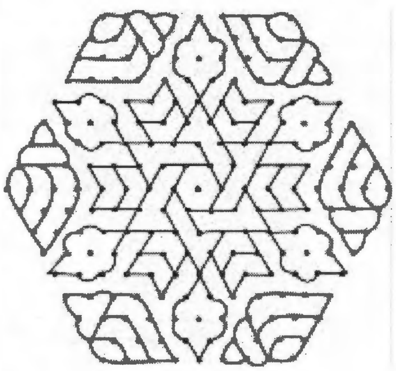

Figure B

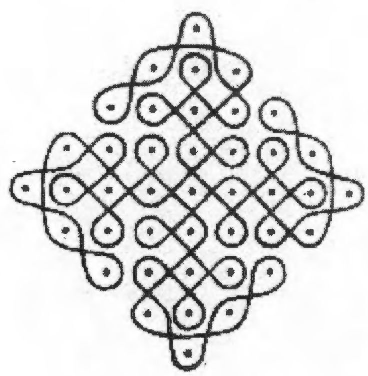

Figure C

Compared to the stick charts of the Marshall Islanders, it was easier for me to see the mathematics tied to the kolam. The geometry is more repetitive and symmetry is more common in the kolam than in the stick charts of the Marshall Islanders. Kolam can be used to instruct students on symmetry, transformations, and congruence. Figure B exposes students with rotational symmetry and congruence of shapes. The dots of the kolam provide a scaffold for students' explanation of how they know shapes are congruent. Figure C allows students to explore rotational symmetry, with curves instead of strictly straight lines. A strategy to help students visualize the relationships within the kolam, is to have them color the congruent shapes. From there, students can determine any type of symmetry within the shapes or the kolam as a whole. A lesson for students to explore geometric transformations through kolam is included in Appendix B.

Java and Bali

The Javanese-Balinese culture is one that Ascher writes about when discussing the cycle of time. The Javanese-Balinese culture utilizes the Gregorian calendar as well as a rather peculiar calendar, Pawukon (Ascher 2002). The Pawukon calendar consists of ten different weeks of different lengths that cycle concurrently. The weeks have one, two, three, four, five, six, seven, eight, nine, and ten days. Each day has a different name, depending on the week. There are 210 days in the Pawukon calendar, consisting of six months of 35 days. The Pawukon calendar is not memorized by the Javanese or Balinese, but it is referred to when scheduling ceremonies.

Some weeks of the Pawukon calendar are more important than others. The three-day, five-day, and seven-day weeks are more valued because of use and religious belief among the Javanese-Balinese people. Neighborhood markets are scheduled during the three- and five-day weeks in Balinese and Java, respectively. These weeks are also given more attention due to three and five holding cultural significance among the Balinese (Ascher 2002). Using the lesson in

Appendix A about least common multiples, intermediate students would be able to determine when the start of weeks would coincide in the Pawukon. Another aspect of the lesson is for students to calculate which weeks do not have 210 as one of their multiples and the implications of the weeks not going evenly into 210.

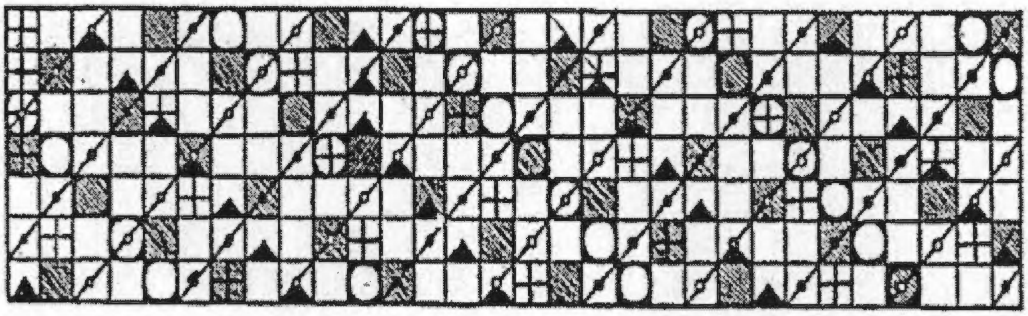

Figure D

When reading about the Javanese-Balinese calendar, I could grasp the concept of concurring weeks. Deciphering a traditional *tika*, a representation of the entire Balinese calendar in Figure D, required a key because of the various symbols and the coinciding of various days. While the purpose of a one- or two- day week puzzled me, I saw the potential for the activities in my classroom. The *tika* and the Pawukon calendar provide a cultural stage for mathematics, and are excellent exemplars for students to see how mathematics and culture are interrelated.

Judaism

The purpose of calendars is to record the cycles of time. Some cultures record the passage of time by the solar cycle and some record it by the lunar cycle. The Jewish calendar uses both the solar and lunar cycles to create the calendar. Some lunar years have 13 months in them and others have 12. The cycle of leap-years and non-leap years is 19 years, due to the fact that 19 solar years contains about 235 lunations, and a cycle when 12 lunar years contain 12 months and

7 lunar years contain 13 months. The Sabbath plays an important role in scheduling holidays and creating the calendar. Holidays are confined to occurring in specific months and on specific numerical day in that month. For example, Tishri 10, Yom Kippur, cannot fall on a Friday because no food would be able to be prepared for the Sabbath. If Yom Kippur were to fall on Sunday, then the fasting would continue through Monday due to the inability for the family to prepare food for two consecutive days (Ascher 2002). Another holiday, Tishri 21, Hoshanah Rabbah, cannot be observed on the Sabbath because it requires carrying around objects, which breaks the Sabbath. The restrictions of these two holidays limits the days Tishri 1 can fall on. The Jewish calendar integrates the lunar and solar cycles as well as holidays and leap years in determining the start of the year. Another activity is to have students create their own calendar using events in their lives, they can base it either on the lunar or solar cycles, and compare the week cycle to the Gregorian calendar.

The Jewish calendar is one that provided me with the opportunity to make connections with my background knowledge in operations research. The connections were drawn due to the number of limitations in determining the first day of the calendar based on holidays and stipulations for that holiday. Analyzing and determining the date of a holiday in the Jewish calendar involves critical thinking skills, while considering several restrictions, once again illustrating the integration of mathematics within culture.

<u>Using Cultures of the Students to Teach Mathematics</u>

The children bring their own culture and experiences to the classroom. The enjoyable part is getting to know their culture and incorporating parts of it into the lessons. In my experience in central Indiana, I have been in classrooms with a minority majority, including students who are

Hispanic and African American. Here, I focus on Hispanic culture, due to the increase of the Hispanic population over the past decade. In 2000, 3.5% of Indiana's population was Hispanic or Latino, and in 2014, approximately 6.6% of Indiana's population was Hispanic or Latino (Indiana 2015).

Culture and mathematics are not something modern students think of as being related. Having a context and a personal relation to what you are learning helps you grasp the concept you are trying to learn quicker. For example in the culture of baseball, baseball players have batting averages, which is the number of hits divided by the number of times the player is at bat. If a student has a background in baseball, but struggles with ratios or probability, providing him or her the problem in the context of batting averages will help him or her gain a deeper understanding of the material. Similarly, different ethnic cultures can be used as a foundation for acquiring mathematical knowledge.

Serapes or Mexican blankets are iconic in Mexican culture. Serapes are a variation of a cape, and some of them have holes in the middle for the wearer's head. The serape are typically worn by men who work in the mountains. The textile eventually became popular among American tourists and is still sold to vacationers (Hall 2015). Serape have a dominant color, which is used to identify the largest, boldest stripe of the blanket. Some serape have a diamond pattern in the middle (Tesoros). Both of these types of designs, stripes and diamonds, can be used for calculating percents, ratios, or analyzing the geometric transformations in the diamond pattern.

In the Hispanic culture, family is everything. Talking to students about their traditions and their grandparents' traditions is a reliable source to gain a deeper understanding of Hispanic culture as it pertains to an individual classroom (Long 2013). Similarly, research and gaining background knowledge of a culture supplies the teacher with a starting point for classroom discussion. The basis of food is a good place to start in most cultures. To provide students with a common experience and a chance to share their culture, as a class you can make bring in recipes and discuss what would happen if you needed to make the recipe for a larger group or a smaller group than the recipe yields (Appendix C). This would require students to scale the recipe by either multiplying or dividing by fractions. There are several cultures in a classroom, and to help the students feel that their culture is meaningful it is vital to incorporate the various cultures throughout the school year.

Using Popular American Culture to Teach Mathematics

People living in the same society have similar values. With the United States of America being a capitalist nation, money, belongings, and ownership are vital to the cultural definition of success. Today's students may not be aware of the societal undertones, but they are familiar with goods and services. Money, dollars, and cents are familiar, tactile ways to teach children about more and less, decimal operations, and place value. For older children in mathematics courses, money can be used to model systems of equations, model linear equations, examine the relationship between circumference and diameter, and explore the basic formula used to calculate interest. The mathematics classes provide the opportunity for students to question, "Does my answer make sense?" and "Which option is best?" Asking these questions are ways for students to be self-sufficient when it comes to calculations and decision making, which are skills vital to students' ability to navigate the world and make educated decisions. The United

States is a nation of choices, and as educators it is partially our responsibility to teach children how to calculate the best choice for them.

Fashion and clothing designers utilize two-dimensional geometry to create an object to be worn by a human, a three-dimensional being. A designer cuts pieces of fabric so that when it is sewn with other pieces of fabric there is enough space in the shape created that a person's body can fit inside. This process is similar to the geometric nets of three-dimensional objects, such as prisms, cones, and pyramids. The designer has a final shape in mind, and certain body type must be able to fit in the clothes. An additional challenge comes into play when the fabric has a pattern and the designer wants the pattern to continue, but use the least amount of fabric possible. Now we have a real-world mathematics problem, one with nets, area, and minimization. This problem can be used at various levels of mathematics, from intermediate levels involving area, where students are asked to find the area of the fabric that would be used to create the garment, to advanced levels of mathematics involving minimization of area.

The common experience of American culture and using students' interests are ways to make the mathematics meaningful to students, as well as helping the students feel valued. Respecting and acknowledging students' interests in the mathematics classroom nurtures the whole child. Instructing mathematics using topics that are not thought of as requiring mathematics, helps students see that mathematics and culture are intertwined.

Final Thoughts

Above all, it is vital to make mathematics meaningful to children. Tying in cultures of the students shows that mathematics and culture are intertwined, and every culture, past and present, is valuable. Mathematics is integrated throughout cultures and daily life. In a time of multiculturalism it is important to value and respect all cultures of the world and of the school. As a teacher, integrating cultures from outside the classroom and using them as a foundation of education, provides students the opportunity to learn not only about mathematical ideas, but the world. Acknowledging that students have different experiences and interests, then integrating mathematics throughout the classroom culture leads to students feeling valued and realizing that their experiences are meaningful. Integration of current culture and mathematics within the school curriculum could include the arts, science, and other more explicit topics students are learning across content areas. Correlation between mathematics and life, mathematics and another content area, or students' prior knowledge help provide students with a solid foundation and deeper understanding of mathematics.

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Appendix A

Calendar Lesson Plan

Standard

Indiana Standard 6.NS.7: Find the greatest common factor of two whole numbers less than or equal to 100 and the least common multiple of two whole numbers less than or equal to 12. Use the distributive property to express a sum of two whole numbers from 1 to 100, with a common factor as a multiple of a sum of two whole numbers with no common factor

Objectives

Students will determine the whole numbers by which 210 is divisible.
Students will find the least common multiple of 3, 5, and 7, as well as 4 and 6 using the context of the Pawukon calendar.

Materials

Paper
Pencil
Grid Paper (optional)

Instructional Plan

Engagement

The Bali culture has a complicated calendar, one with many weeks of different lengths happening at the same time. The Pawukon calendar is rooted in the schedule of growing rice in Bali. There are one-day weeks, two-day weeks, three-day weeks, and so on, up to ten-day weeks. Days often have different names depending on the week cycle that is emphasized. The Pawukon calendar has 210 days, with six months, each consisting of 35 days. <u>How is this calendar different than our calendar?</u> (We have the same number of days in each week, and this calendar has different number of days in the weeks. The weeks also run at the same time.)

Exploration

Our calendar, the Gregorian calendar, has 52 whole cycles of seven and one-fourth days. In the Pawukon calendar, <u>will all weeks run a whole number of cycles?</u> <u>How do you know? Which weeks will run through a whole number of cycles?</u>

On their own, students will explore least common multiples.

From handout: "The Balinese calendar focuses on the 3-, 5-, and 7- day weeks. On your own, determine the number of days it will take for the start of the three-day week to coincide with the start of the five-day week.

Once you have done that, determine the number of days it will take for the start of the three-, five-, and seven-day weeks to coincide."

What pattern do you notice?

What strategy are you using to solve this problem?

Will the coinciding starts always be the same number of days apart?

Explanation

Students will share the ways they determined the day on which the start of the weeks will coincide. What they have just found is the least common multiple of the numbers 3, 5, and 7. Least common multiple will help the students when they learn the traditional method for adding and subtracting fractions.

How are the different ways of solving the problem related?

How could least common multiples help the Bali people?

Is there a shorter way for us to determine the least common multiple?

Extension

Now, hypothesize the number of days it will take for the start of the 4- and 6-day weeks to coincide. Show how you determined your answer. Was your hypothesis correct? Why or why not? Compare the pattern you see to the pattern used to find the solution for the 3-, 5-, and 7-day weeks.

Evaluation

Students will be evaluated on their analysis of other students' work, as well as their own work. The work in Part 1 of the activity will evaluate students' abilities to determine the factors of a number. The work and analysis in Part 2 will assess the students' abilities to determine the least common multiple of numbers that are relatively prime, whereas the work in Part 3 will assess the students' abilities to determine the least common multiple of numbers that have a common factor.

Pawukon Calendar Activity

Part 1: Determining the Number of Weeks with Complete Cycles

Our calendar, the Gregorian calendar, has 52 whole cycles of seven days. The Pawukon calendar has weeks of one, two, three, four, five, six, seven, eight, nine, and ten days that all cycle through at the same time. There are 210 days in the Pawukon calendar.

In the Pawukon calendar, will all weeks run a whole number of cycles? How do you know? Which weeks will run through a whole number of cycles? Show your work.

The following weeks run complete cycles: ____.

I know because____

____

____

Part 2: Coinciding Starts

The Balinese calendar focuses on the 3-, 5-, and 7- day weeks. On your own, determine the number of days it will take for the start of the three-day week to coincide with the start of the five-day week.

Once you have done that, determine the number of days it will take for the start of the three-, five-, and seven-day weeks to coincide.

Show your work.

A. **Coinciding Start of 3- and 5-day weeks**

The weeks' starts coincide on day _________.

B. Coinciding Start of 3-, 5-, and 7- day weeks

The weeks' starts coincide on day _________.

What pattern do you notice?

Part 3: Coinciding Start of 4- and 6-day Weeks

Now, hypothesize the number of days it will take for the start of the 4- and 6-day weeks to coincide. **Show how you determined your answer**. Was your hypothesis correct? Why or why not? Compare the pattern you see to the pattern used to find the solution for the 3-, 5-, and 7-day weeks.

Hypothesis: ____

Work:

Hypothesis Correct? Yes or No

Reason: ____

____

____

Comparison of Patterns: ____

____

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Guided Questions

Find Out

- What is the question you have to answer?
- How long are each of the weeks?

Choose a Strategy

- You can use a diagram, calendar, or draw a picture to solve this problem.

Solve It

- When you make your diagram, how days will be in each week?
- How many days have passed when each week has completed two cycles?
- Make an estimate for how many days will have passed when the start date will coincide.

Look Back

Read the problem again. Look at the information given and the main questions. Review your work. Is your answer reasonable?

Appendix B

Kolam Geometry Lesson Plan

Standards

Indiana Standard 8.GM.3: Verify experimentally the properties of rotations, reflections, and translations, including: lines are mapped to lines, and line segments to line segments of the same length; angles are mapped to angles of the same measure; and parallel lines are mapped to parallel lines

Indiana Standard 8.GM.4: Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations. Describe a sequence that exhibits the congruence between two given congruent figures.

Objectives

Students will be able to analyze the relationship between figures when they are rotated, reflected or translated.

Students will be able to determine if two figures are congruent.

Students will be able to explain the properties of rotations, reflections, and translations.

Materials

- Paper
- Pencil
- Colored Pencils or Crayons
- Triangle Dot Paper
- "Kolam and Geometric Transformations" Handouts
- "Kolam Extension Activity" Handout

Instructional Plan

Engagement

In the region of Tamil Nadu, India women often create designs called kolam in front of their houses. Kolam is a design consisting of dots and lines using rice powder. The kolam is thought to bring prosperity to the home. Different designs are created in front of the house for different holidays or occasions. These designs contain symmetry and various geometric shapes.

Exploration

Students will each be given a kolam and asked to color all of the shapes that are congruent. They will record any patterns they notice. Students will analyze how the kolam was created by answering the questions on the handout. They are the following:

What transformations are used in kolam you looked at? (Translations, reflections, rotations)

How are the shapes that are rotated related to one another?

What patterns do you notice in the kolam?

What relationship do you notice between the transformed figures and their pre-images?

Explanation

Students will share their discoveries in small groups. Each person will share how they determined the figures within the kolam were congruent.

How are the different kolam related?

What transformations did you find in your kolam?

What happens when a part of the kolam is rotated?

Extension

Design your own kolam and explain the transformations you used in it. How would you instruct people so they could recreate your kolam without seeing it? Make a list of instructions for them to follow.

Evaluation

Students will be evaluated based on their responses to questions on the handout.

Name ______________________________

Kolam and Geometric Transformations

Choose a row or column of kolam. Then, color each set of congruent figures in the kolam with a different color. Then answer the following questions:

How did you determine if a shape has congruent figures in the kolam?

____

____

____

____

What transformations are used in the kolam you looked at? (Translations, reflections, rotations)

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How are the shapes that are rotated related to one another?

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What patterns do you notice in the kolam?

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What relationship do you notice between the transformed figures and their pre-images?

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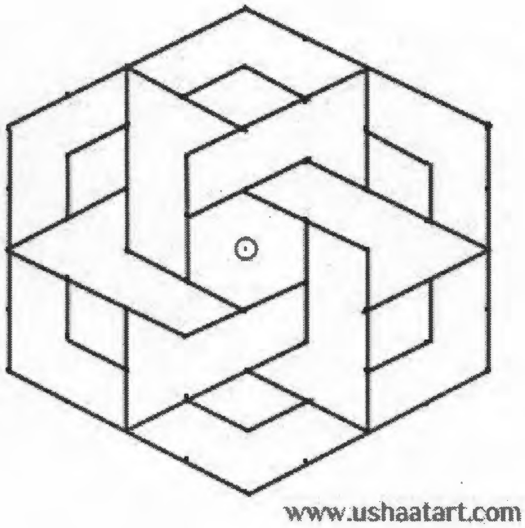
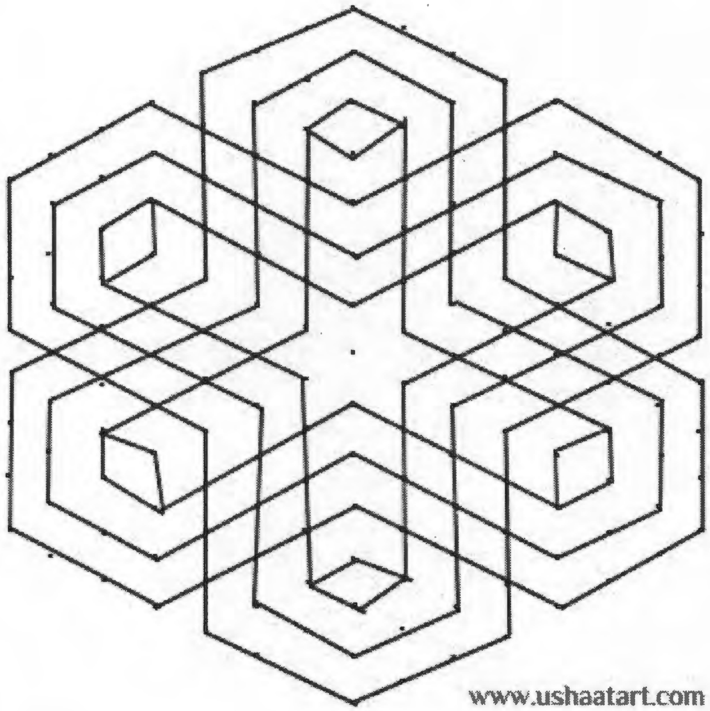
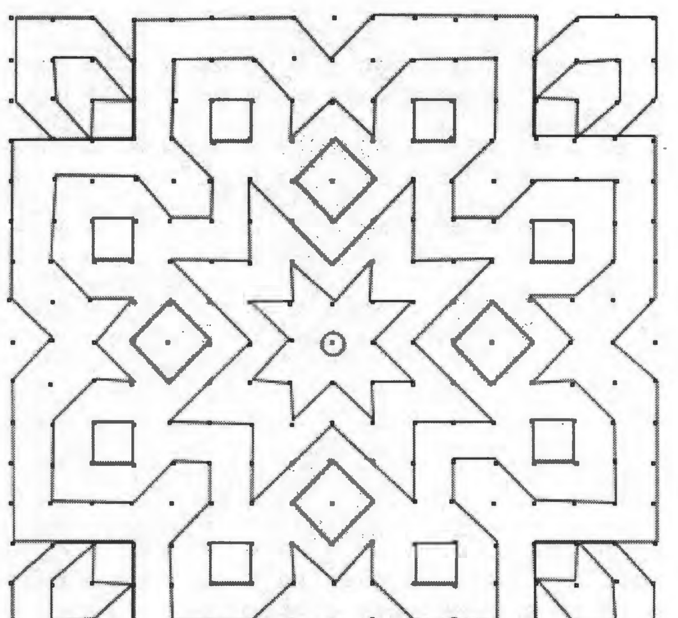
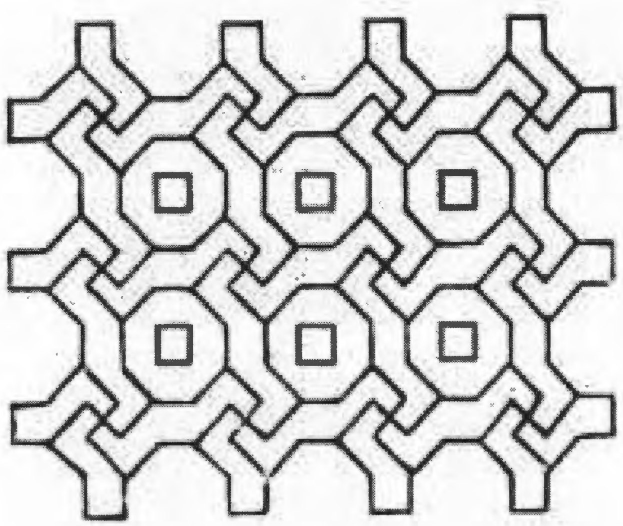
Kolam for Activity









Name ______________________________

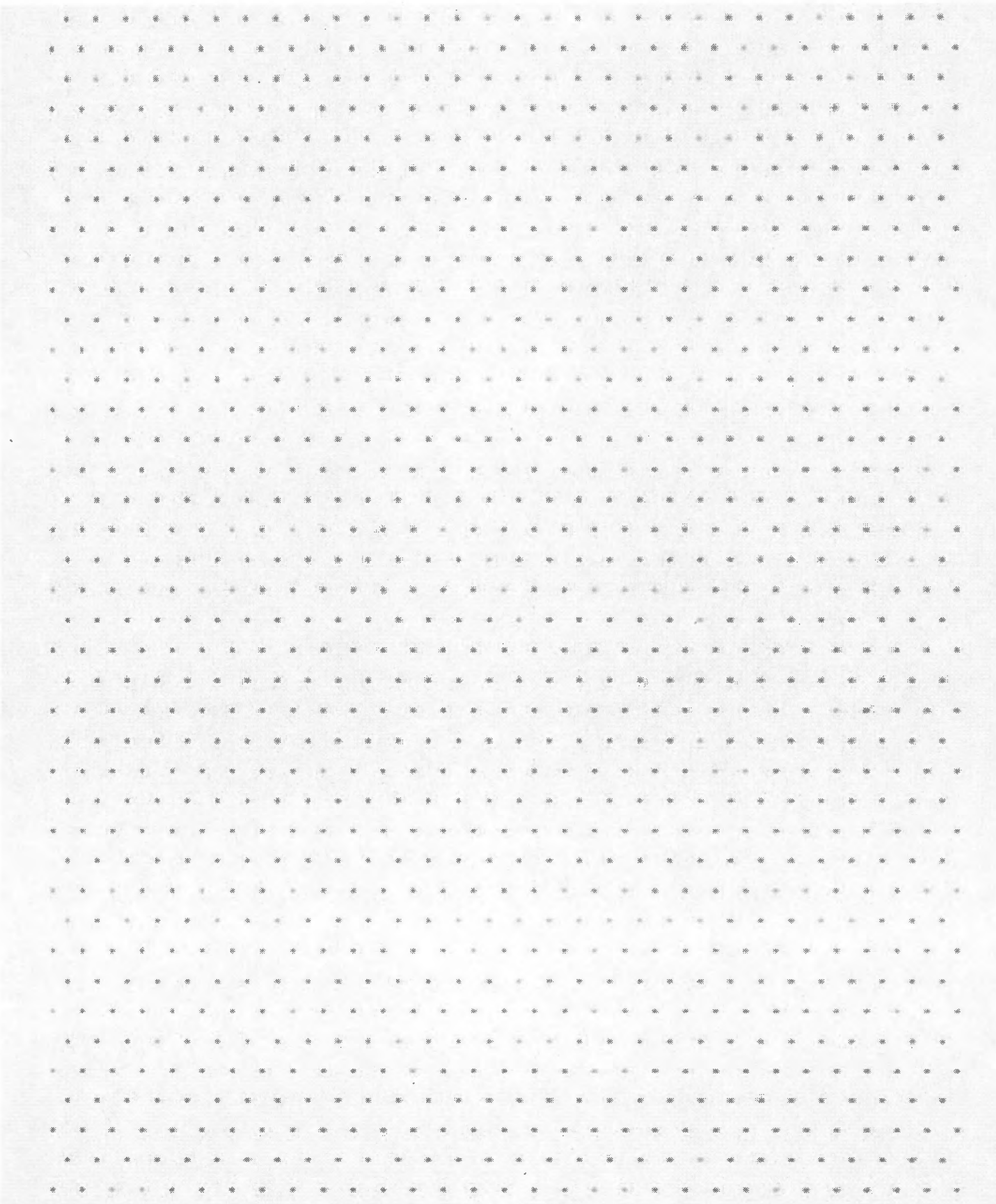
Kolam Extension Activity

1. Design your own kolam on the dot paper.

2. Explain the transformations you used in your kolam.

3. Write directions so someone could recreate your kolam without seeing it.

Triangle Dot Paper



Appendix C

Recipe Fraction Lesson Plan

Standard

Indiana Standard 5.C.5: Use visual fraction models and numbers to multiply a fraction by a fraction or a whole number.

5.C.7: Use visual fraction models and numbers to divide a unit fraction by a non-zero whole number and to divide a whole number by a unit fraction.

Objectives

Students will be able to scale a fraction by a whole number.
Students will be able to model multiplying and dividing a fraction by a whole number.

Materials

Paper
Pencil
Recipes (Enchiladas and Tamales)
"Scaling a Recipe" Instruction Sheet
"Scaling a Recipe Answer Sheet"
"Guided Questions" Handout

Instructional Plan

Engagement

Recipes use fractions of ingredients, and recipes make a certain amount of food. But what would we do if we wanted to make more food for people, and not make several batches?

Exploration

With a partner, determine how much of each ingredient you would need if you doubled or tripled a recipe. Also, determine how much of each ingredient each cook will get if there are three or five cooks working together to make a single batch. If students need help, I will give them the "Guided Questions" handout and answer any questions they have throughout the process.

Explanation

Student pairs will partner up to share how they solved the problem. Groups will then share how their methods for solving the problem were similar with the whole class. Students will

have worked on multiplying and dividing fractions by a whole number. If this is not brought up explicitly, state it and ask students how their method related to multiplication and division.
What operations did you use to scale your recipe?
How did you scale the recipe?
How were your methods similar?
How were your methods different?

Extension

As an extension, students will determine the amount of each ingredient is needed given a number of servings. For example, ask students how much of an ingredient is needed if we wanted to have 60 enchiladas.

Evaluation

Students will be evaluated based on their work and the answers given on the answer sheet. This activity will assess the students' abilities to multiply and divide a fraction by a whole number.

Scaling a Recipe

Part 1: Multiple Batches

With a partner, choose a recipe. Then, determine how much of each ingredient you would need if you doubled or tripled a recipe. **Show your work and record your final answer on the answer sheet.**

Part 2: Multiple Cooks Making One Batch

With the same recipe, determine how much of each ingredient each cook will get if there are three cooks working together to make a single batch. Then determine how much each cook will get if there are 5 cooks working to make a single batch. **Show your work and record your final answer on the answer sheet.**

Name ________________________________

Scaling a Recipe Answer Sheet

Ingredient	Amount for One Batch	Amount for Double Batch	Amount for Triple Batch	Amount for Three Cooks	Amount for Five Cooks

Scaling a Recipe to a Specific Yield

Now, your task is to determine the amount of each ingredient so that you can make the given number of tamales or enchiladas.

Ingredient	Amount for Batch of 60 Enchiladas	Amount for Batch of 84 Enchiladas	Amount for Batch of 48 Tamales	Amount for Batch of 80 Tamales

Enchilada Recipe

This recipe makes 12 enchiladas.

- 4 guajillo peppers, seeds removed.
- 4 ancho peppers, seeds removed.
- 2 garlic cloves chopped
- 1/4 teaspoon Mexican oregano
- Salt and pepper to taste
- 12 corn tortillas
- 2 cups of shredded beef, pork or chicken (optional)
- 1 1/2 cup of fresh cheese crumble
- 1/2 cup of white onion finely chopped
- 1/3 cup of vegetable oil

Optional Garnishes:

- 2 cups of pre-cooked diced potatoes and 2 cups of pre-cooked diced carrots.
- Finely shredded lettuce or cabbage and radishes

Directions

1. Slightly roast the peppers in a hot griddle, pressing them flat with the help of a spatula. Make sure NOT to burn them. This step takes a few seconds on each side of the peppers.
2. Once roasted, place them in a saucepan with water and turn the heat to medium and simmer for about 15 minutes or when they look soft.
3. Remove saucepan from stove and let them cool for another 10-15 minutes. The pepper skins should look soft.
4. After the resting period, drain the peppers and place in the blender along with the garlic cloves. Add 1/2 cup of clean water and blend until you have a smooth sauce. If necessary, strain the sauce into a large bowl using a fine strainer. Season with the oregano, salt and pepper, and set aside.
5. Pre-heat your oven to 350 degrees to keep the enchiladas warm while you finish assembling them. Add the 2 tablespoons of vegetable oil in a large skillet at medium heat. Add oil little by little as needed. Too much oil will get a soggy tortilla.
6. Dip the tortilla into the sauce to lightly coat each side.
7. Place it in the Frying Comal-pan or skillet and briefly fry a few seconds on both sides. Add more vegetable oil to the skillet as needed. Place fried tortillas in a dish while you make the rest of the tortillas to keep warm in the oven.
8. To assemble the enchiladas, first place the filling in the center of the tortilla and fold it. Sometimes I place a meat filling into the center of the tortilla and then roll it.
9. Sprinkle the enchiladas with the cheese and onion. Add the garnish of your choice and enjoy!
10. If you decide to add the potatoes and carrots as garnish: Peel potatoes and carrots, cut in cubes and boil until almost tender but still firm. Then drain and cool.
11. Use the same frying pan where you fried the enchiladas to lightly fry the potatoes, adding a little more oil. The potatoes and carrots will be coated with some of the sauce sticking to the frying pan. Season with salt and garnish with cheese.

(Martinez 2015)

Tamale Recipe

This recipe makes 16 medium size tamales.
INGREDIENTS:

- 6 cups of sweet corn kernels (about 5 ears of corn)
- 1 1/2 cup of Corn Masa for Tamales
- 1 1/4 cup of butter at room temperature
- 1/2 cup of sugar
- 1 teaspoon baking powder
- 1 teaspoon salt

DIRECTIONS:

1. Cut off the end of the corn cob with a sharp knife. You can also make a small cut to the tip of the husk to have an even wrap.
2. Remove the husks, making sure you do not tear them since you are going to use them as a wrapping for the tamales and place them in a large pot cover with hot water. This step will make the husks soft and pliable.
3. Place the cob standing up and with a sharp knife slice off downward to remove the kernels. You can place the ear of corn inside a large shallow bowl to keep all the kernels from spilling onto your working area while cutting it.
4. Place the kernels into a food processor to lightly grind them. The mixture has to be medium coarse. This step is usually made in a corn grinder but a food processor works just fine. If a food processor is not available, use your blender* and process in small batches.
5. Measure the corn flour and place in a large bowl along with the corn kernels already processed.
6. In another bowl, beat the butter, sugar and salt until fluffy and light. You can use a spatula for this step if you don't want to use the mixer.
7. Add the butter mixture to the large bowl with the corn flour and kernels.
8. Add the baking powder and mix until well combine. The texture of the mix will be of a thick batter.
9. Remove the husks from the pot and drain excess water. Select the ones you are going to use to wrap the tamales. Use the small husks to cover the bottom of the Steamer where you are going to steam the tamales.
10. Place about 3 tablespoons of the dough into the center of the flatten husk and fold to form the tamales.
11. Repeat this process to form the rest of the tamales.
12. Add hot water to a large pot with a steamer basket and place tamales inside. Cover tamales with the rest of the corn husks and cover with the lid. Steam Tamales for 1 hour and 15 minutes. To check for doneness, unwrap a tamal. The dough will come off easily from the corn husk. If the dough sticks to corn husk, re-wrap and steam 15 to 20 more minutes.

(Martinez 2015)

Guided Questions

Find Out

- What is the question you have to answer?
- What ingredients involve fractions?
- What number do we want to multiply each ingredient by?

Choose a Strategy

- You can use a diagram, make a table, or draw a picture to solve this problem.

Solve It

- When you scale each ingredient, what do you do?
- What fraction of is needed for each ingredient? How would you represent/show that?
- How would you show how much of an ingredient was needed?
- Make an estimate for how much of each ingredient is needed to scale the recipe.

Look Back

Read the problem again. Look at the information given and the main questions. Review your work. Is your answer reasonable?